Feasibility Study

MBTA Railroad Bridge (near Christina Street) over Charles River
Newton - Needham, Massachusetts

Revision 1 (7/7/2021)

JUNE 2021

PREPARED FOR

The City of Newton

PREPARED BY

vhb

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Table of Contents

1 .... Project Location and Bridge Information 1

1.1 Project Location 1
1.2 Bridge Information 1
1.3 Introduction 1

2 .... Description of Existing Site Conditions 3

2.1 Description of Existing Bridge Structure 3
2.2 Description of Approaches 5
2.3 Description of Feature under the Bridge Structure 6
2.4 Description of Utilities within the Bridge Site 7
2.5 Environmentally Sensitive or Cultural Resource Areas Affecting the Bridge Site 8
2.6 Hazardous Materials 9

3 .... Description of Project and Site Parameters 10

3.1 Description of Proposed Multi-Use Rail Trail Cross Section 10
3.2 Traffic Management Considerations 10
3.3 Proposed Bridge Clearances 11
3.4 Preliminary Hydraulic and Geotechnical Data 11
3.5 Constraints Imposed by Approach Features 12
3.6 Constraints Imposed by Feature Crossed 12
3.7 Constraints Imposed by Utilities 12
3.8 Constraints Imposed by Environmentally Sensitive Areas 13
3.9 Hazardous Material Description 13

4 .... Appropriate Bridge Alternatives 14

4.1 Alternative Identification 14

5 .... Proposed Substructure Arrangement, Span, and Foundation Type 16

5.1 Alternative A - Existing Multi-Span Concrete Piling 16
5.2 Alternative B - Single Span on New Abutments on Existing Alignment 17
5.3 Alternative C - Single Span on New Abutments on New Alignment 18

6 .... Proposed Superstructure Type 19

6.1 Alternative A - Bridge Rehabilitation 19
6.2 Alternatives B & C - Prefabricated Steel Truss 21

7 .... Preliminary Bridge Cost Estimate 23

7.1 Preliminary Bridge Cost Estimate 23

7.2 Preliminary Bridge Life Cycle Cost Analysis 24
7.3 Preliminary Total Project Costs 24

8 ....Comparison of Proposed Bridge Alternatives 26

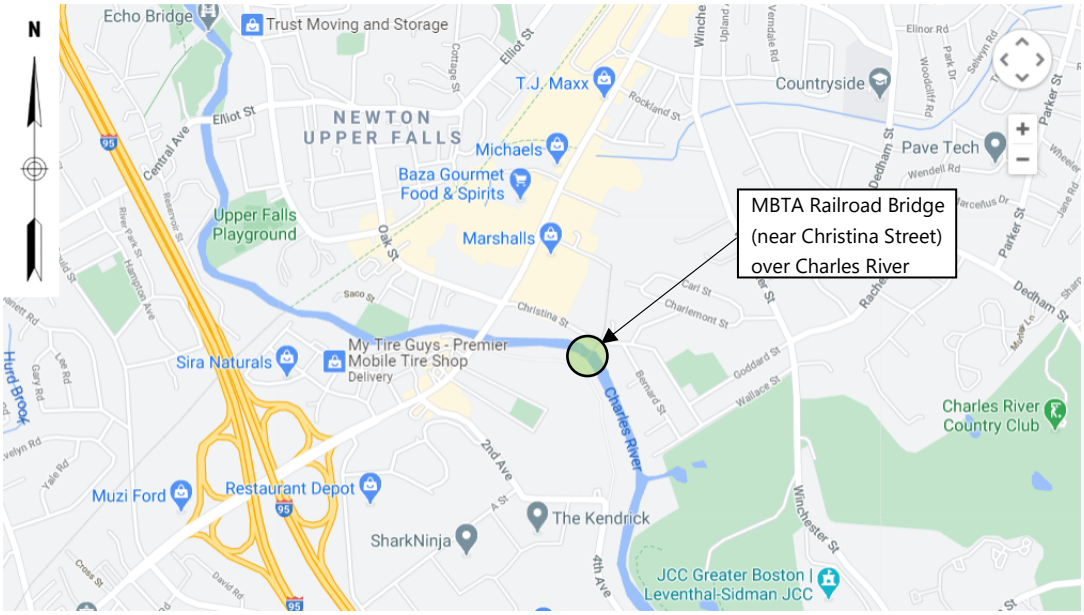
8.1 Alternatives Assessment and Conclusions 26

9....Appendices

9.1 Figures 1 through 6 – Plans, Elevations, and Sections
9.2 Bridge Cost Estimate
9.3 Bridge Life Cycle Cost Analysis
9.4 Total Project Cost Estimate
9.5 September 2020 Underwater Inspection Report
9.6 Approach Connection Aerial Plan
9.7 Potential Approach Connection through Barry Price Center Property

1 Project Location and Bridge Information

1.1 Project Location



Project Locus Map

1.2 Bridge Information

Town: Newton & Needham

Bridge Number: N/A (Record License Plan No. 3516)

Facility on Bridge: Abandoned MBTA ROW

Feature Intersected: Charles River

1.3 Introduction

The purpose of this feasibility study is to document existing site conditions and relevant design parameters in relation to three bridge design alternatives to help in selecting the preferred alternative. When selecting an alternative, there are several critical parameters to be considered first, including safety and functionality of the bridge. Secondly, there are other preferred parameters that should be optimized to the extent practicable and compared between alternatives, including design life and future maintenance needs, the environmental impacts, construction timelines and impacts to surrounding properties and traffic, and aesthetics, among others

described within this report. When there is more than one acceptable alternative which have a similar balance of preferred parameters, the third consideration is the cost of the different alternatives, including the up-front design and construction costs as well as the life cycle costs of the bridge.

2 Description of Existing Site Conditions

2.1 Description of Existing Bridge Structure

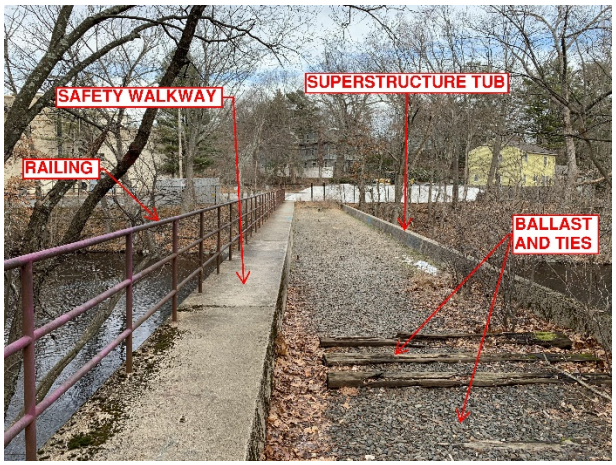
The existing bridge is a 7-span concrete pile trestle structure with a ballasted deck supporting a single abandoned track over the Charles River in Newton & Needham, MA. The trestle was constructed in 1959, making it approximately 62 years old. The existing bridge configuration generally consists of the following:

- The bridge is oriented east west, with the east approach (Newton) at grade, and the west approach (Needham) on a fill embankment
- Each span length is approximately 20'-0", with an approximate resulting bridge length of 140'-0".
- The bridge is just south (upstream) of Highland Ave., Needham and Needham Street, Newton.

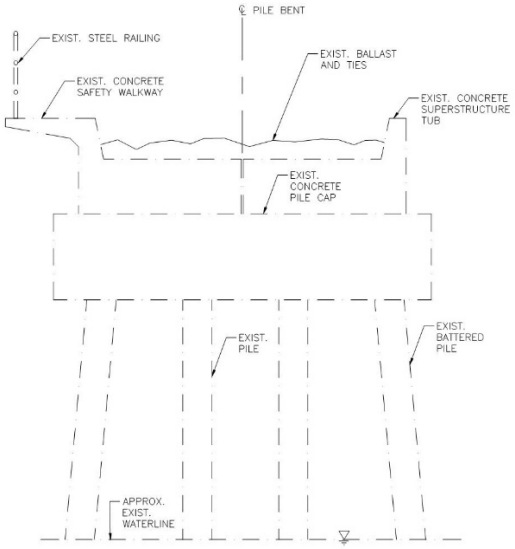
Existing Bridge - Looking South

Existing Superstructure:

- The out-to-out width is 16'-0", including an elevated walkway of 3'-7".
- The ballasted track is supported by a concrete 'tub' type structure, that is 3'-9.5" deep. The concrete slab depth is 2'-2".



Existing Bridge Top of Deck



Existing Bridge Typical Section

Existing Substructure:

- The concrete tub is supported on 3'-5"x2'-0"x15'-1" long concrete pile caps.
- Typical piers are made of four-14" diameter concrete piles with non-structural steel casing, the outside two piles being battered.
- Abutments also consist of concrete pile caps supported on piles.

Existing Bridge Pier

Existing Pile condition

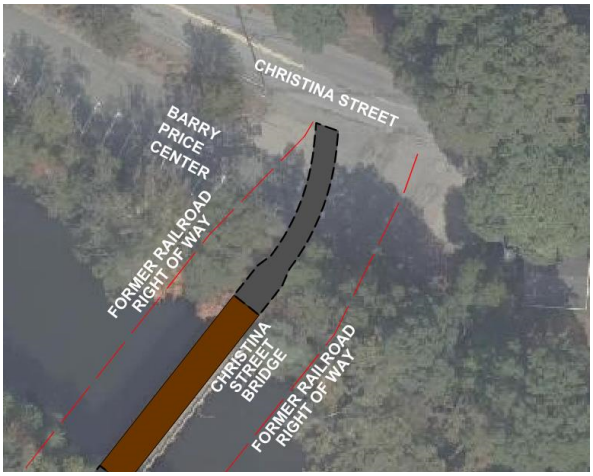
Bridge Condition and Load Rating:

There was no existing load rating or bridge inspection report available at the time of this study. There is an existing underwater inspection report from 2020, which looks at the condition of the piles only. The report indicates the piles are in critical condition (condition rating of 2). The outer steel casing is noted as deteriorated up to 100% at the waterline, with exposed concrete having heavy abrasions. Three piles have 100% section loss for 2'-3" above the waterline.

A visual inspection of the bridge was also completed by VHB in April of 2021. The concrete superstructure was found to be in overall good condition, with localized areas of deteriorated and spalling concrete. The waterproofing system and longitudinal deck joints between superstructure pieces have failed. The concrete pile caps were also in satisfactory condition, with minor spalling at corners or edges. Some erosion was noted at both abutments, where the retained riprap and ballast has started to spill through the piles.

2.2 Description of Approaches

- The east approach has abandoned ties immediately off the bridge for several feet, then there is a locked gate which connects to the Barry Price Center's parking lot (private property) and then Christina Street.
- The west approach has abandoned ties with overgrown brush the entire length to the Blue Heron trail (DCR land).
- The nearest access to the east of the bridge is the parking lot at 27 Christina Street (Barry Price Center) which is approximately 10 feet east.
- The nearest access to the west of the bridge is off the Blue Heron trail which is approximately 200 feet west.
- The former railroad right of way (ROW) in the area of the bridge is approximately 70 feet wide.
- There is also a footpath along the western bank of the river, that crosses over the ROW approximately 5 feet off the bridge.
- A full aerial plan of the required approach connections shown below can be found in Appendix 9.6.
- A full aerial plan of one potential alternative for connecting the east approach through the Barry Price Center property is shown in Appendix 9.7. The option shown is only one of many discussed, and it is included as an example for future considerations.



East Approach with Schematic Connection to Christina St

Eastern Approach View (Looking East)

West Approach with schematic connection to DCR Trail

West Approach view (Looking West)

2.3 Description of Feature under the Bridge Structure

The existing former railroad bridge spans the Charles River approximately 1100 feet south of Highland Ave/Needham Street in Needham/Newton, MA. The River flows from south to north at this location and generally is a slow-moving waterway. The channel is approximately 100 feet wide at the bridge and the natural river width is about 115 feet wide beyond either side of the bridge.

No hydraulic data was available at the time of this study. A hydraulic study will be required during future phases of this project to determine scour requirements for the design of any new foundations and possibly to support permitting requirements. None of the proposed alternatives are anticipated to have a significant effect on the hydraulics at this location, and the existing clearance will not be affected.

Aerial View of Project Site (Looking Downstream)

- The observed water level was approximately 9.4' feet below the bottom of the pile cap in September 2020.
- The banks on the upstream and downstream of the bridge consist of larger trees with other heavy vegetation, with some boulders scattered around.
- This is not a navigational channel however the Charles River is heavily used in the warm weather for canoeing and kayaking. A maintained canoe launch at Nahanton Park is located just ¾ of a mile south (upstream) of the bridge.
- Outside of the ROW, the Department of Recreation and Conservation (DCR) owns the property on the western side of the Bridge (left bank), the eastern side of the bridge is owned by the Barry Price Center (right bank).

2.4 Description of Utilities within the Bridge Site

Overhead Utilities:

There is an existing utility pole (UP #9) with a light at the easterly end of the existing driveway and parking lot at 27 Christina Street (Barry Price Center). This pole is part of a utility pole line that continues along Christina Street in both directions. The pole also has an overhead electrical feed to a light pole at the eastern most part of the property and a guy wire that connects to an existing tree along the Charles River (adjacent to the NE corner of the existing bridge).

Underground Utilities:

On the west side of the Charles River there is a 56-inch reinforced concrete pipe and headwall to the south of the west bridge abutment. The 56-inch pipe flows from the southwest where there is a drain manhole. The 56-inch reinforced concrete pipe continues southwest and presumably goes under the Blue Heron Trail.

On the east side of the Charles River there are two (2) sewer manholes that were found within the parking lot at the easterly end of 27 Christina Street. Additional research and/or field recon may be required to determine where the existing pipes are located (if any).

Existing drainage structures within Christina Street have been identified. Additional pipe and elevation information may be required as the design progresses.

There is also a 4" diameter existing metal conduit along the northern fascia of the bridge structure, which disappears underground at each bank. It is unknown at this time if there are active utilities present in the conduits or if they are abandoned.

Existing Conduit Along the North Fascia of Bridge

2.5 Environmentally Sensitive or Cultural Resource Areas Affecting the Bridge Site

Riverfront and wetland resource areas associated with the Charles River are present on both sides of the bridge and are subject to federal, state, and local jurisdiction. Wetland resources and the limits of the river channel have not yet been delineated but would include the bank of the river and any adjacent vegetated wetlands, as well as the land under the river itself.

- The bridge is not located within any Massachusetts Natural Heritage and Endangered Species Program (NHESP) estimated habitats of rare wildlife or priority habitats of rare species.

- The bridge is within a FEMA designated floodplain, but this stretch has not been designated as a floodway.
- The Charles River at the bridge site has not been designated as a Wild and Scenic River or a coldwater fisheries resource.
- The bridge was inventoried (WAY.916) but is not listed on the National Register of Historic Places. The bridge is also not within an historic district.

2.6 Hazardous Materials

Railroad right-of-way's (ROW) are often impacted with residual oil and/or hazardous materials (OHM), including metals, pesticides, and petroleum constituents such as polycyclic aromatic hydrocarbons (PAHs). Railroad-related sources of OHM may include creosote- or arsenic- laced railroad ties, herbicides, lubricating oils, diesel fuel, and diesel exhaust. In addition, fill of unknown origin used to bring tracks to grade may contain debris, coal, coal ash, coal slag, or other potential contaminants.

3 Description of Project and Site Parameters

The project parameters described in this section include those which are most likely to affect the feasibility or comparison of the bridge alternatives described in Section 4. This section does not describe a comprehensive list of project parameters or design criteria. Additional parameters were discussed in the public process and stakeholder engagement meetings during the development of this report. Those discussions are documented in their respective meeting notes. More detailed parameters will be considered during the future design phases of this project.

3.1 Description of Proposed Multi-Use Rail Trail Cross Section

The proposed multi-use rail trail will be designed in accordance with the 2006 Massachusetts Highway Department Project Development & Design Guide, 521 CMR The Rules and Regulations of the Massachusetts Architectural Access Board, the AASHTO Guide for the Development of Bicycle Facilities, 2012 edition, the AASHTO Policy on Geometric Design of Highways and Streets, and the American with Disabilities Act (ADA).

The proposed trail approaches will be composed of 4-inch thick hot mix asphalt and the bridge surface will be timber decking, exposed concrete deck with roughened broom finish, or hot mix asphalt.

- Total paved cross section width of at least 10 feet
- Total width between railings of at least 14 feet (10-foot trail, plus AASHTO standard 2-foot shoulders to railings)
- Maximum design speed of 20 miles per hour (may be adjusted in next design phase)
- Maximum allowable path gradient of five percent (5%) in conformance with the ADA

3.2 Traffic Management Considerations

The nearest access to the bridge site is on the east side of the bridge crossing, at the easterly end of 27 Christina Street (Barry Price Center), and construction is anticipated to temporarily impact the driveway and parking lot circulation. Depending on the

final design, temporary pedestrian bypasses may be required for the sidewalk along Christina Street to ensure safe pedestrian access through construction.

To access the western end of the bridge, coordination with DCR will be required to allow the Contractor to use the existing paved Blue Heron Trail that begins at Highland Avenue. It appears that the existing trail would provide enough space for the Contractor to mobilize and bring in moderately sized construction equipment. Public access along this 1000-foot section of the Blue Heron Trail would be temporarily impacted to allow the Contractor to do this. The 200-foot section between the Blue Heron Trail and the westerly bridge abutment would be closed off to the public during construction. It is anticipated that the Contractor may need to perform selective clearing and thinning and tree trimming along this 100-foot section.

Coordination with the community, abutters, the Town of Needham, City of Newton, MBTA and DCR will be required. See Section 3.8 for environmental considerations.

3.3 Proposed Bridge Clearances

The existing streambed grading and low chord (bottom of superstructure) elevation will be maintained or improved. A maximum 30-inch profile depth from top of trail to bottom of the bridge structure is required to maintain the low chord elevation. Additionally, the new single-span bridge alternatives would increase the horizontal hydraulic opening.

3.4 Preliminary Hydraulic and Geotechnical Data

Hydraulic data for this location was not available at the time of this report. See section 2.3 for available information on the river at this location. All alternatives will either maintain or improve the existing low chord elevation and hydraulic opening at the structure. It is assumed that maintaining the existing low chord is acceptable, however, a hydraulic study will need to be completed which will confirm flood surface elevations and clearance requirements.

There was no geotechnical information available for this bridge at the time of the study. Investigative borings and geotechnical recommendations will be required during future phases of this project, in order to finalize any new bridge foundation designs.

3.5 Constraints Imposed by Approach Features

- The connection to Christina Street on the eastern approach goes through the Barry Price Center parking lot, which is private property. This section of the trail design and access to the bridge site will need to be thoughtfully coordinated with the Barry Price Center and the City of Newton. Impacts to parking, traffic flow, snow storage etc., will be coordinated and designed in such a way that meets the needs of the property and the necessary safety requirements associated with its current owners.
- The existing rail corridor on the west side of the bridge is surrounded by trees and vegetation and may not provide a large area for construction staging without extensive clearing. The corridor is also straight and elevated above the surrounding forested area, two constraints which create significant impacts and challenges with any western approach alignments that diverge from the existing alignment.
- It may be practical to design the bridge, permanently or temporarily, to carry some construction vehicles given the distance to roadways on the western approach.

3.6 Constraints Imposed by Feature Crossed

There are no extraordinary physical constraints imposed by the river that would affect the construction of the bridge. In-river work would be required for the bridge demolition or pile repair work. For a replacement alternative, the minimum span length and maximum structure heights are set to meet existing clearances, and the abutments will be positioned land side of the existing abutments to limit excavation impacts to the waterway.

3.7 Constraints Imposed by Utilities

Constraints imposed by utilities are as follows:

- The nearest access to the project site is from the east adjacent to Christina Street. The use of a crane may require the overhead wire and guy wire in the vicinity to be at least temporarily relocated.
- The desired line for the proposed path and potential future path across Christina street conflicts with the existing driveway opening. Potential to shift this driveway opening can be explored and would require the utility pole (UP #9 with light) along Christina Street to be permanently relocated. Impacts to the overall overhead line and guying would need to be evaluated.
- There is an existing 56-inch concrete pipe and headwall approximately 6 feet south of the west abutment, and impacts to this should be avoided.

3.8 Constraints Imposed by Environmentally Sensitive Areas

- Any work done in any vegetated wetlands or below ordinary high water will be limited to the maximum extent practicable and permitted through Section 404 of the federal Clean Water Act, as necessary. Any fill of vegetated wetlands or waterways will require compensatory mitigation.
- Any in-water work will require environmental permitting, including Chapter 91 and a Section 401 Water Quality Certification, and control of water measures during construction.
- An Order of Conditions will be required from the Newton and Needham Conservation Commissions.
- If a replacement option is chosen, it may be necessary to reconstruct the streambed after demolition and removal of the existing piles.
- Disturbances outside of the existing footprint but within jurisdictional areas (e.g. Riverfront Area, buffer zones) need to be minimized to the maximum extent practicable. This includes consideration of temporary impacts due to construction staging, temporary traffic control, control of water to facilitate construction in the dry, and time of year restrictions for construction timing.
- If trees are proposed to be removed, consultation with the U.S. Fish and Wildlife Service will be required to assess any potential impacts to the northern long-eared bat (*Myotis septentrionalis*).
- Excavation and control of water operations (pumping/piping) within the streambed, which can be disruptive, should be minimized.
- Control of turbidity within the river from construction operations through use of erosion controls and turbidity curtains will be needed.
- Any in-water work may be limited to the low-flow time of year (July, August, September).
- In-water or overwater work will need to accommodate recreational use of the river.
- Any loss of floodplain storage volume (filled area) will need to be replaced incrementally on a foot by foot basis.

3.9 Hazardous Material Description

The railroad ROW may be impacted by contaminants as described in Section 2.7. Therefore, during construction of the project, special handling and management of soil in the ROW may be required in accordance with the MassDEP Rail Trail Guidance if there is evidence of impacts. Any hazardous materials located within the project site shall be handled in accordance with all local, State and Federal regulations. Additionally, best management practices shall be specified during the next design phase of the project and implemented during construction.

4 Appropriate Bridge Alternatives

4.1 Alternative Identification

All alternatives will be designed to accommodate pedestrian bridge design loading of 90 pounds per square foot. Standard practice also designs for a 10-ton vehicle (such as an ambulance), which does not add significant cost or capacity requirements by design for spans in this range.

Alternative A consists of rehabilitating and retrofitting the existing concrete trestle bridge to accommodate the above bridge design loadings, the full trail width, and pedestrian railing requirements. This is an appropriate alternative to consider as it has minimal permanent impacts to the existing conditions and the proposed design loadings are smaller than the existing bridge's train design loadings. For the purpose of this report, we have assumed a 40-year design life with the rehab recommendations we discuss in the following sections.

Alternative B considered a single-span replacement bridge on the existing alignment. To minimize impacts to the river and maintain low chord elevation and existing profile, the span will be approximately 146.5 feet with a structure depth (top of deck to bottom of superstructure) of approximately 30 inches. New abutments would be perched behind the existing abutment pile bents, putting construction activities father away from the edge of the river. This option would provide a standard 75-year design life for the new structure.

Alternative C considered a single-span replacement bridge on a new proposed alignment to the North, still in the original railroad right-of-way, while leaving the existing bridge un-touched and to be demolished at a later date when necessary or when additional funding becomes available. To minimize impacts to the river and maintain low chord elevation and existing profile, the span will be approximately 144 feet, matching the existing structure's abutment locations, with a structure depth of approximately 30 inches. This option would provide a standard 75-year design life for the new structure.

Appropriate new bridge structure types for spans ranging 110-feet and 150-feet are: through-trusses or through-girders, steel deck I-girders or box girders with composite decks, or prestressed concrete New England bulb tee (NEBT) deck girders with a composite concrete deck; however, the limited available superstructure depth, which needs to match the existing to avoid raising the grade over the bridge, makes

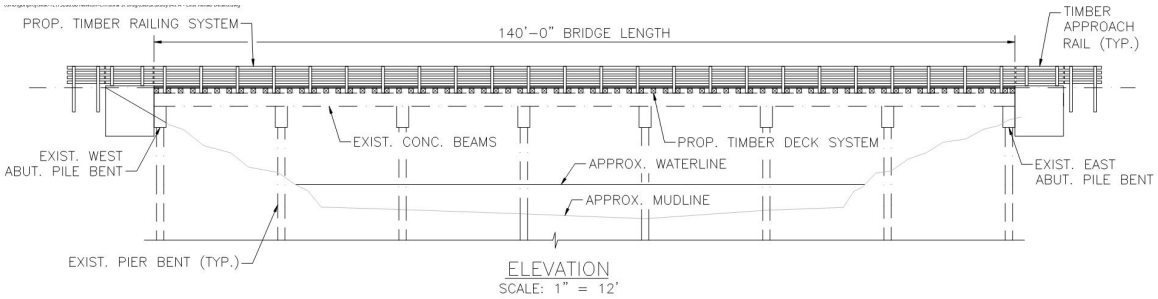
deck beam and slab bridges impractical, and considering this is a pedestrian bridge, a steel truss is likely the most cost-effective and easily constructable when compared to a heavier through-girder bridge. A signature bridge style, such as a tied arch, could be used at this location but is not considered for this feasibility study when comparing these three alternatives. Thus, the second and third alternatives (B and C) included in this report consider a prefabricated single-span steel through truss bridge on new abutments.

5 Proposed Substructure Arrangement, Span, and Foundation Type

Due to the lack of geotechnical information, assumptions were made with the available information. Additional analysis will be conducted when further geotechnical information is gathered.

5.1 Alternative A - Existing Multi-Span Concrete Piling

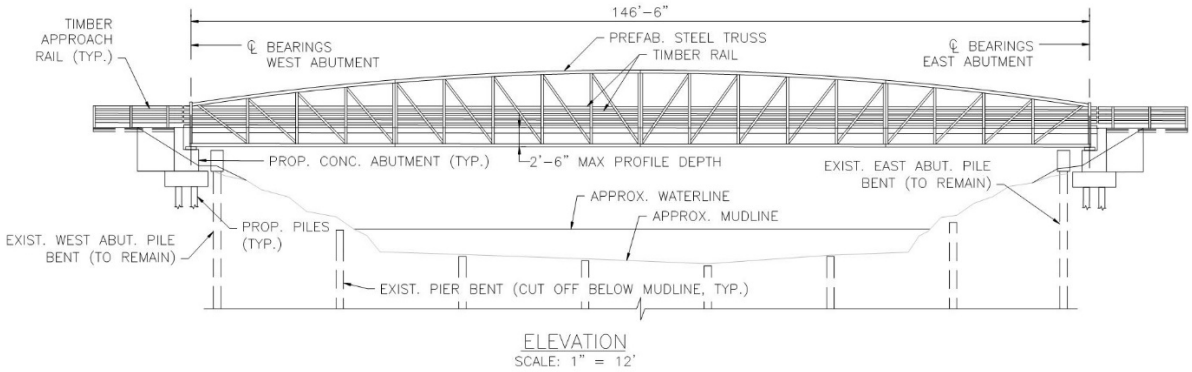
- Maintaining the existing concrete pile bents results in the least permanent impacts to the structure and its surroundings.
- With repairs bringing the existing substructures up to satisfactory condition, a comparative analysis shows their capacity will be adequate for a pedestrian bridge with a new deck, given its original design and use as a railroad bridge.
- There are six piers, each with four concrete piles with steel casing and a concrete pile cap. The exterior piles are battered.
- The abutments are of similar construction to the piers however they appear to be slightly undermined (particularly at the east abutment), with large gaps under the pile caps where soil and ballast have spilled through.
- 7 piles to receive moderate repairs with a structural wrapping system and additional repairs to section loss (type 2 repair).
- 3 piles to be repaired for 100% section loss (type 3 repair)
- All remaining piles to be protected from further deterioration by a structural wrapping system.
- All pile caps to be repaired as needed with shallow or deep concrete patching as required.
- Slopes by abutments to be stabilized as required.
- This alternative will not fix or improve the debris that gets caught in the river at this location.



Alt. A - Bridge Rehabilitation

5.2 Alternative B - Single Span on New Abutments on Existing Alignment

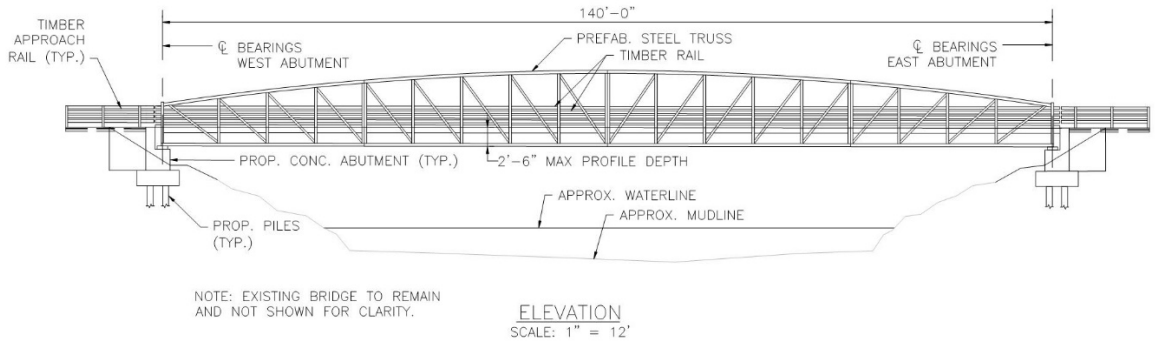
- A single span structure on new concrete abutments perched behind the existing abutments would produce an approximately 146'-6" span length which will utilize the existing abutments to help retain the soil.
- 146'-6" is a reasonable span length for a pedestrian bridge. Piers in the river have adverse environmental and cost implications and are not expected to result in significant superstructure savings, and therefore multi-span arrangements were not considered for this replacement alternative.
- The new abutments are assumed to require deep foundations due to the unknown design scour depth and the existing structure using deep foundations. Given the unknown depth of bedrock and existing subsurface conditions in this area, steel pipe piles, micro-piles, or drilled shafts are assumed appropriate foundation types. For this report we have assumed steel pipe piles.
- The existing bridge and pier bents would be demolished down to the mudline (bottom of channel), removing obstructions in the waterway, and eliminating the problem of debris blocking the river in this location.



Alt. B - Single Span on New Abutments on Existing Alignment

5.3 Alternative C - Single Span on New Abutments on New Alignment

- A single span structure on a new alignment to the north of the existing bridge, on new concrete abutments would produce an approximately 144'-0" span length.
- 140'-0" is a reasonable span length for a pedestrian bridge. Piers in the river have adverse environmental and cost implications and are not expected to result in significant superstructure savings, and therefore multi-span arrangements were not considered for this replacement alternative.
- The new abutments are assumed to require deep foundations due to the unknown design scour depth and the existing structure using deep foundations. Given the unknown depth of bedrock and existing subsurface conditions in this area, steel pipe piles, micro-piles, or drilled shafts are assumed appropriate foundation types. For this report we have assumed steel pipe piles.
- Additional and lengthy retaining walls would be required to build the path up to the necessary grade off the existing alignment, particularly on the north west corner.
- This alternative leaves the existing bridge in place until a later date when funding becomes available or until the condition of the existing bridge requires demolition. Therefore, while the new bridge improves the access to the waterway below, leaving the existing bridge in place negates the benefits of a single span structure.



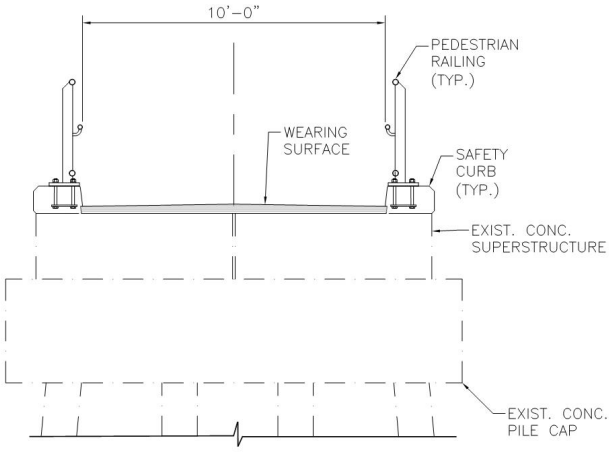
Alt. C - Single Span on One New Abutments on New Alignment

6 Proposed Superstructure Type

6.1 Alternative A - Bridge Rehabilitation

There are a lot of different options for adding a new deck to the existing concrete beams for this structure. Different deck widths and materials were evaluated for this alternative. All options involved demolishing the existing safety walk and sides of the tub structure, before putting a new deck on top of the concrete beams. This is mainly in order to accommodate a new bridge railing that must be fully designed to today's pedestrian and bicycle design loads. Anchoring new railings to the existing concrete in these areas would have been challenging as a lot of the superstructure's deficiencies were found on these parts of the structure and the concrete sections were relatively thin.

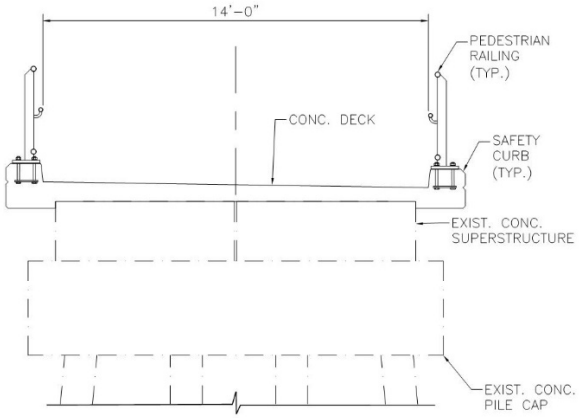
For the purpose of this report, 3 main deck options will be discussed. The first option explored was a narrow width deck, with only 10'-0" clear between railings. This option would pave right over the existing beams, and there is enough room to add new concrete curbs and a metal pedestrian railing, without having to cantilever anything over the edges of the existing beams. This would also offer more continuity as far as aesthetics with the existing concrete structure. This option would cost least in comparison of new deck components, but it provides a substandard usable trail width (6-foot trail with 2-foot shoulders).



10 FT Concrete and HMA Deck Option

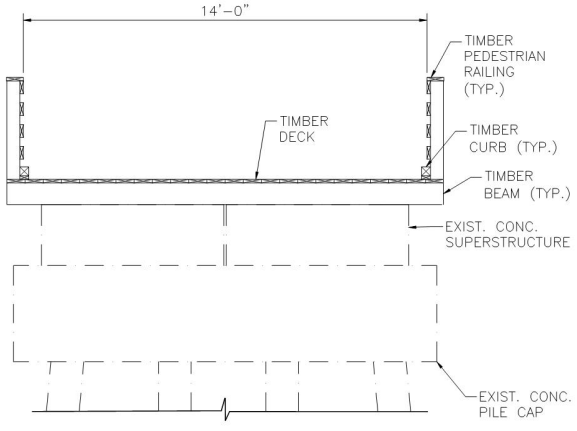
The second decking option explored was similar to the first, in the use of concrete curbs and metal pedestrian railings, however it also included an 8" concrete structural

deck which allowed for cantilevering over the existing concrete beams, to provide a full 14'-0" clear between railings. This option offered a similar aesthetic benefit to the first option, however it was almost double the cost for the deck materials, along with the added challenge of additional formwork over the water.



14 FT Concrete Deck Option

The third option explored was for a timber deck and railing system with 14'-0" clear between railings. This option offers the benefit of additional path width, without the additional formwork for cantilevering out over the water. Timber such as Black Locust could be used, which offers similar durability as concrete, and also offers a more sustainable option and lower embodied carbon than concrete. The timber deck and railing came in between the other two as far as costs, and added about 5% to the overall bridge rehabilitation cost over the narrower first option.



14 FT Timber Deck Option

For these reasons, the third option of a new timber deck and railing system was selected to move forward with for the rehabilitation alternative. It was determined

that the added benefit of the additional path width over the bridge with this option, outweighs the minor additional cost.

The anticipated superstructure work includes:

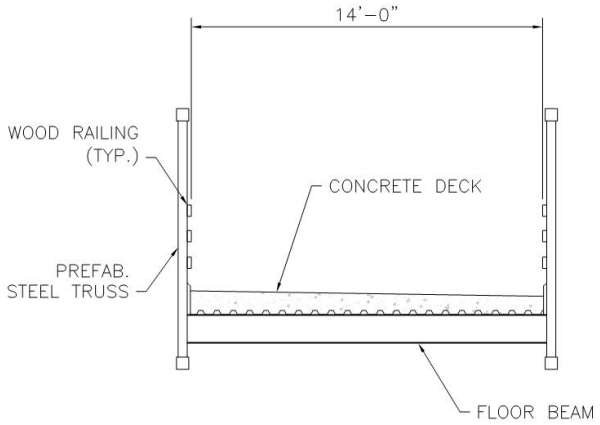
- Remove remaining ties and ballast.
- Demolish the sides of the existing concrete tub section, including the walkway and safety rail.
- Repair existing concrete beams with shallow or deep concrete repair techniques as required.
- Apply new waterproofing membrane to the existing concrete deck beams.
- Install new timber floorbeams and decking.
- Install new timber posts and railings on both sides of the bridge.

6.2 Alternatives B & C - Prefabricated Steel Truss

Alternatives B & C both consider the same superstructure types, just on different alignments. Prefabricated steel through-truss bridges provide the smallest possible depth between the bridge deck and bottom of the structure, which is ideal in this situation to avoid lowering the existing clearance or diminishing the existing hydraulic opening. Due to the span length, a constrained site, and weight of the beams, most concrete beam alternatives would not be practical at this location.

Trusses are generally ideal for bicycle and pedestrian applications at this span length, as they are very efficient structures with respect to strength-to-weight ratios. This can cut down significantly on material costs. As they are primarily shop fabricated, it is anticipated that on site construction may be faster and could result in lower future maintenance costs. Using painted or galvanized steel are recommended for increased life span. Both galvanized and painted has been used on some recent trail projects to achieve the protection of galvanizing, with the aesthetics of a painted color.

Through-truss bridges can accommodate a variety of details to meet the goals of the project, which would be determined during a future final design phase. Some examples of these details include the style of the truss (Constant-depth Pratt Truss or Arching Bow Tie Truss, for example), the railing and screening types, as well as deck finishes (timber, concrete, paved etc.).



14 FT Steel Through Truss

Other considerations and anticipated superstructure work for Alternative B:

- A single span truss would allow for the demolition of the existing piles in the water, which are currently a hazard to anyone using the river below, as they collect debris and offer very narrow spans for travel.
- Prior to removal of the existing piles, it may be possible to utilize the pile bents to assist in a staged bridge launch from one of the approaches.
- The new abutments are being constructed behind the existing abutments, allowing this work to begin prior to the demolition of the existing structure if needed.

Other considerations and anticipated superstructure work for Alternative C:

- A single span truss in the adjacent location would not offer the same benefits to the waterway below the structure until the existing structure is demolished in the future.
- As the existing structure won't need to be demolished prior to installation of the new superstructure, the existing bridge may be used to assist with construction staging and to facilitate easier construction access to both sides of the river.
- With this option being off alignment, it will require significantly more clearing and fill on the approaches to accommodate the new path alignment and elevation.

7 Preliminary Bridge Cost Estimate

7.1 Preliminary Bridge Cost Estimate

Cost estimates have been prepared for the three viable alternatives as discussed above, bridge rehabilitation (A) and prefabricated steel truss on existing (B) or new (C) alignments. The construction cost estimates summarized below are inclusive of all structural items associated with complete replacement of the bridge structure including a 25% contingency, and inflation for a construction year of 2026. These costs are developed for purposes of structural alternative comparison only and will be further developed as the design is progressed. These bridge costs do not include approach work or future design costs. A detailed structural cost estimate for each alternative can be found in Appendix 9.2.

Preliminary Bridge Cost Estimate

Bridge Alternative	Estimated Bridge Costs
Alt. A – Bridge Rehabilitation	$1,164,000
Alt. B – Single Span Prefabricated Steel Truss on Existing Alignment	$1,965,000
Alt. C – Single Span Prefabricated Steel Truss on New Proposed Alignment	$2,141,000

7.2 Preliminary Bridge Life Cycle Cost Analysis

In addition to the preliminary cost estimates, a preliminary life cycle cost analysis (LCCA) was conducted to help illustrate the future costs of each bridge alternative for a 75-year analysis period, which was selected to be equal to the design life of a new bridge. It should be noted that the results from LCCA almost always show deferring costs as the most cost-effective solution. However, it is important to consider the additional administrative work associated with maintaining and repairing an old bridge, the impact to the traveling public as a result of additional maintenance work, risks associated with a deteriorating structure, and availability of funding when maintenance is required or when replacement becomes absolutely necessary. The functionality of the bridge is also important. Replacing a bridge to modern standards may provide additional flexibility in the way the new bridge functions, looks, and accommodates any specific amenities. A detailed life cycle cost analysis and additional assumptions for each alternative can be found in Appendix 9.3.

Preliminary Bridge Life Cycle Cost Analysis (75-years)

Bridge Alternative	Estimated Bridge Costs
Alt. A – Bridge Rehabilitation	$1,435,000
Alt. B – Single Span Prefabricated Steel Truss on Existing Alignment	$1,978,000
Alt. C – Single Span Prefabricated Steel Truss on New Proposed Alignment	$2,292,000

The numbers above are the anticipated life span bridge-only costs for each structure alternative, which is important to compare to the up-front costs show in section 7.1. As anticipated, the rehabilitation shows the cheapest bridge lifecycle cost, but the differential costs between it and the replacement alternatives is smaller due to the additional mid-cycle maintenance and future replacement costs.

7.3 Preliminary Total Project Costs

The bridge costs in the sections above can be used for comparison between alternatives. In developing a project budget for the preferred alternative, the approach construction costs, final design costs, and construction administration costs should also be considered. The approach work cost will be similar for all options and are estimated at $270,000. The design fee and construction admin costs are estimated as a percentage of the total construction cost. The total project costs for budgeting are shown in the table below. These costs are all estimated to take placed in 2026 and they do not include future maintenance costs. A detailed total project cost for each alternative can be found in Appendix 9.4.

Preliminary Total Project Cost for Budgeting

Bridge Alternative	Estimated Project Costs
Alt. A – Bridge Rehabilitation	$1,630,000
Alt. B – Single Span Prefabricated Steel Truss on Existing Alignment	$2,510,000
Alt. C – Single Span Prefabricated Steel Truss on New Proposed Alignment	$2,710,000

8 Comparison of Proposed Bridge Alternatives

8.1 Alternatives Assessment and Conclusions

Based on our assessment of the above referenced design and environmental constraints, both Alternative A, Bridge Rehabilitation and Alternative B, Single Span Prefabricated Steel Truss on Existing Alignment, are feasible options in this location to be selected for implementation at the Christina Street bridge location crossing over the Charles River. Given the constraints and increased complications with building a new bridge off-alignment, Alternative C is not recommended for further consideration as compared to the other alternatives.

The bridge rehabilitation alternative (A) achieves the goals of the project and has the shortest construction duration. Additionally, the rehabilitation alternative more closely maintains the existing aesthetics of the crossing and is the lowest construction cost alternative. Furthermore, life cycle cost analysis shows that rehabilitating the bridge and delaying bridge replacement by 40 years or more has a lower total life cycle cost.

The full bridge replacement on existing alignment (B) achieves other goals of the project, providing a brand-new structure with lower future maintenance requirements and a design life of 75 years. The single span also eliminates the hazards in the river due to the existing piers and debris that collects against them. Furthermore, this alternative limits the work in the river, as removing the piles is much simpler than extended repairs. This alternative is the second least expensive alternative.

Below is a summary table of parameters to consider for each of the two remaining feasible options (Alternatives A & B) when determining a preferred alternative.

Summary of Key Parameters for Consideration

Parameter	Alt. A - Rehabilitation	Alt. B – Replacement
Functionality	New deck fully designed to accommodate multi-use purposes. While piles will be repaired, the existing issue of debris-build up and pile interference with waterway below will remain.	New structure fully designed to accommodate multi-use purposes. Removal of the existing piles will remove obstructions in the river and create a safer environment for recreational use on the water below the bridge.
Design Life and Maintenance	40-year design life max, and ~~will likely~~may require additional maintenance in ~~as soon as~~ 10-20 years	75-year to 100-year design life, and minimal future maintenance
Additional Project Risk Factors	Unknowns with the existing structure encountered during construction can cause an increase in costs or impacts to the schedule, prolonging impacts to the surrounding properties	No additional risks beyond typical bridge projects
Environmental Impacts	Repair of existing piles will require more extensive work in the River	Removal of existing piles will require minimal work in the River
Construction Considerations	Shorter estimated construction duration and smaller equipment required for out-of-water work.	Longer estimated construction duration. Though accelerated bridge construction techniques could be utilized to minimize impacts to surrounding properties.
Aesthetics	Existing aesthetics mostly maintained below the new bridge deck.	New bridge – differs from existing, but a wide variety of aesthetic looks can be accommodated.
Bridge Construction Cost **Bridge Life Cycle Cost*** **Total Project Cost**	$1,164,000 $1,435,000 $1,630,000	$1,965,000 $1,978,000 $2,510,000

*It is recommended to compare alternatives using the non-cost parameters first, then use Bridge Life Cycle Costs to weigh the premium for the difference.

9 Appendices

9.1 – Figure 1 through 6 - Plans, Elevations, and Sections
9.2 – Bridge Cost Estimate
9.3 – Bridge Life Cycle Cost Analysis
9.4 – Total Project Cost Estimate
9.5 – September 2020 Underwater Inspection Report
9.6 – Approach Connection Aerial Plan
9.7 – Potential Approach Connection through Barry Price Center Property

9.1 – Figure 1 through 6 – Bridge Plans, Bridge Elevations, & Bridge Sections

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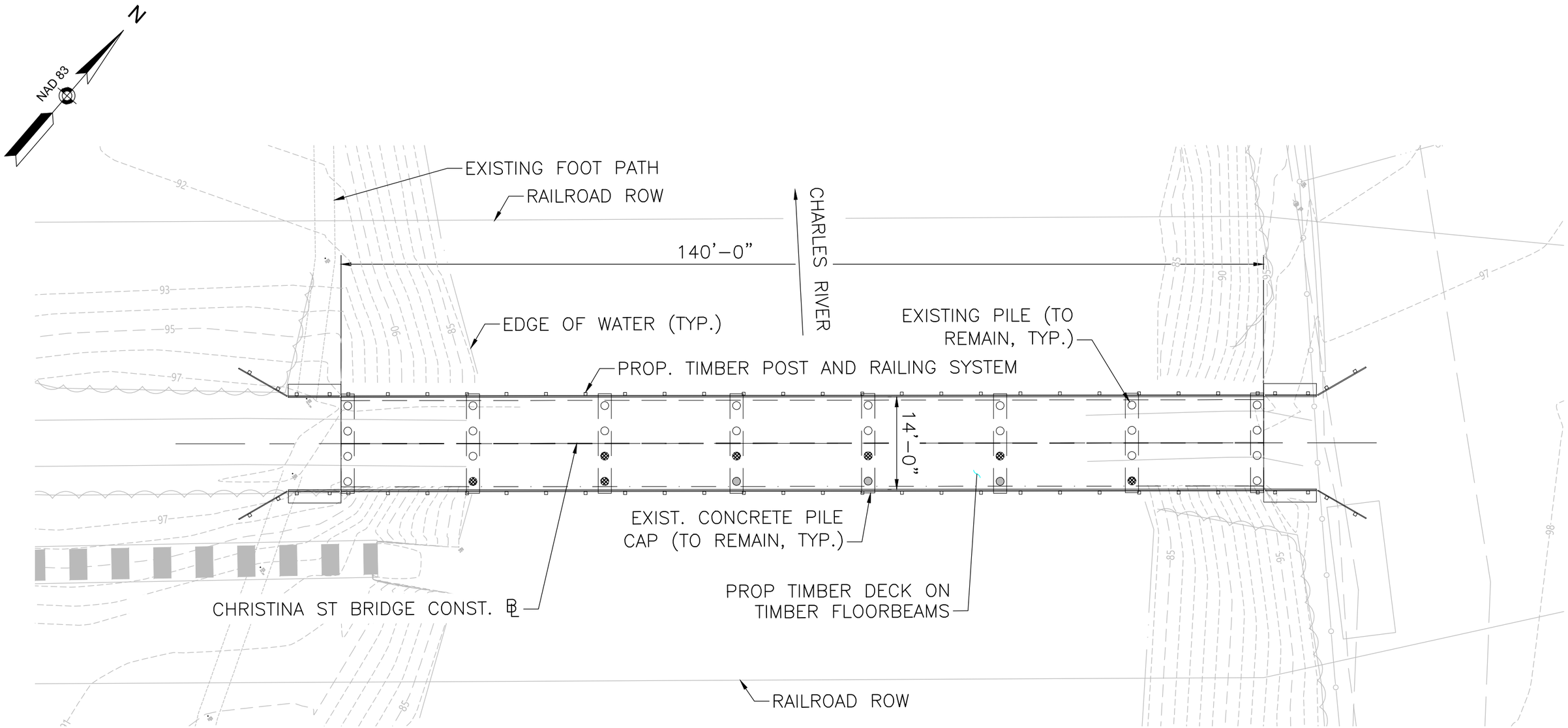

PLAN – ALTERNATIVE A

SCALE: 1" = 15'

FIGURE 1
PLAN – ALTERNATIVE A
CHRISTINA STREET FEASIBILITY STUDY
NEWTON & NEEDHAM, MA
JUNE 16, 2021

ANTICIPATED PILE REPAIRS:
- TYPE 1 REPAIR (INSTALL PROTECTIVE WRAP)
- TYPE 2 REPAIR (INSTALL PROTECTIVE WRAP AND GROUT SURFACE VOIDS)
- TYPE 3 REPAIR (FULL DEPTH CONCRETE REPAIR AND PROTECTIVE WRAP)

NOTE: NO ANTICIPATED REPAIRS TO ABUTMENT PILES

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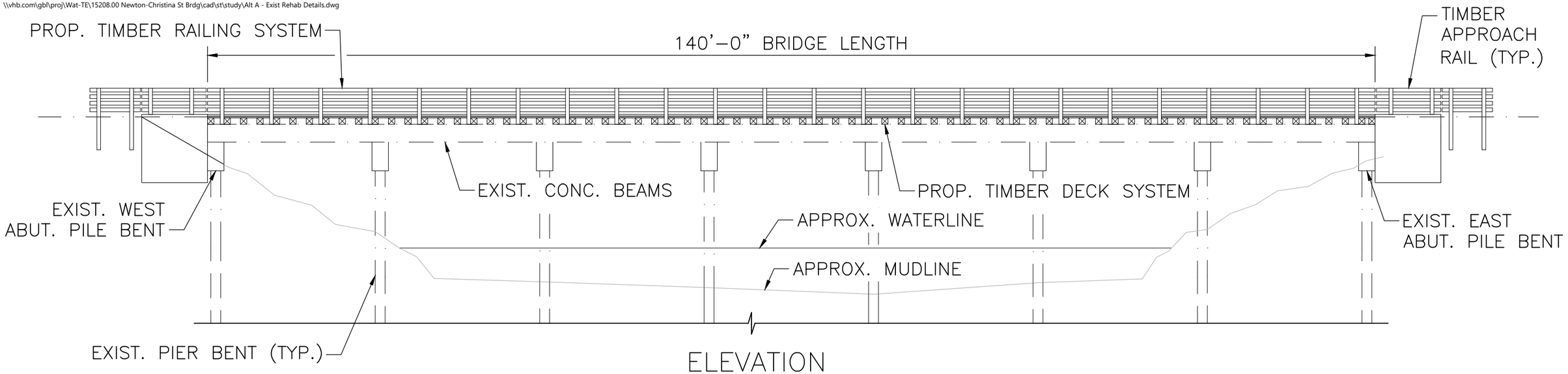
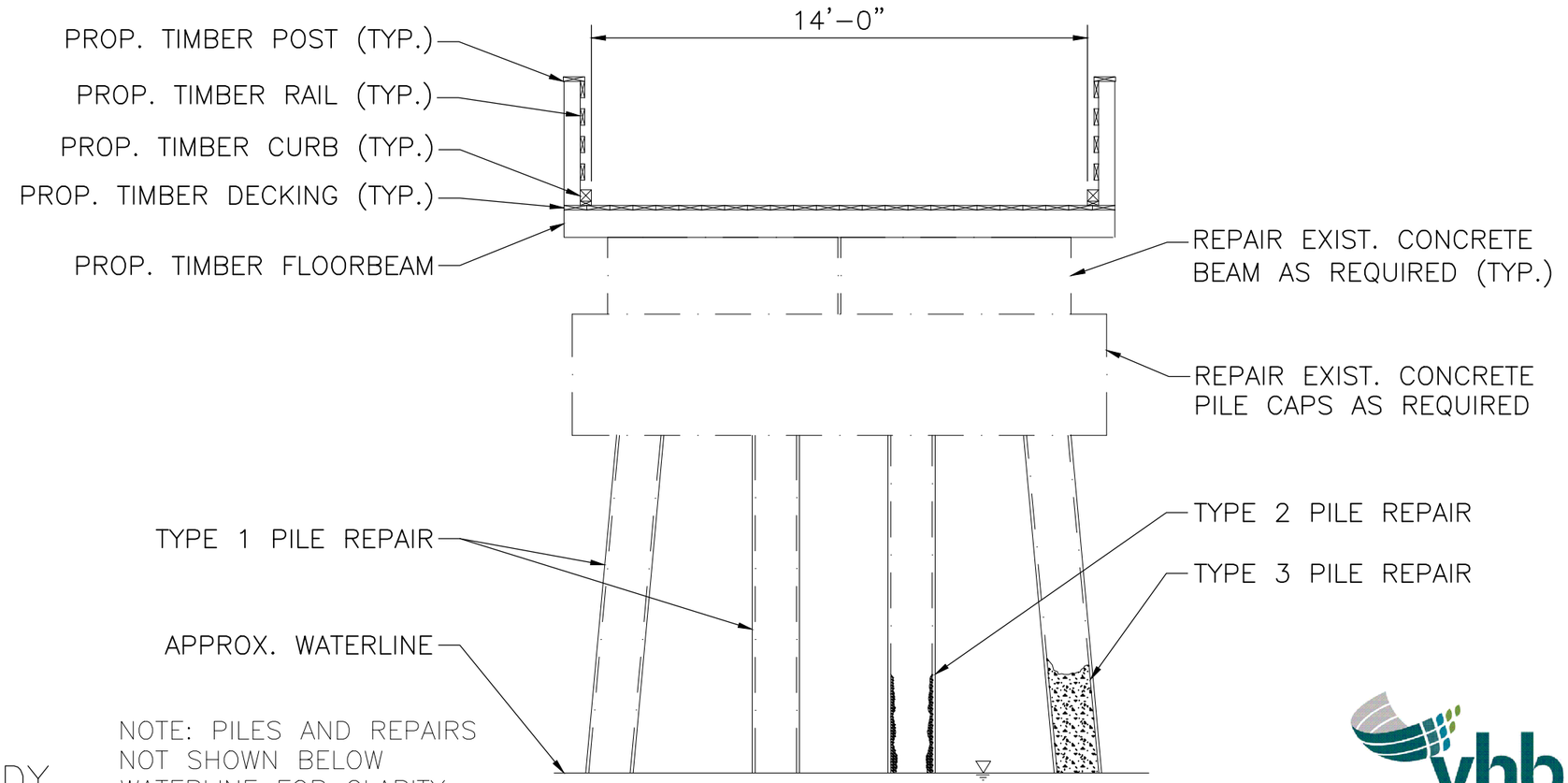


ELEVATION

SCALE: 1" = 12'


14'–0"
PROP. TIMBER POST (TYP.)
PROP. TIMBER RAIL (TYP.)
PROP. TIMBER CURB (TYP.)
PROP. TIMBER DECKING (TYP.)
PROP. TIMBER FLOORBEAM
REPAIR EXIST. CONCRETE BEAM AS REQUIRED (TYP.)
REPAIR EXIST. CONCRETE PILE CAPS AS REQUIRED
TYPE 1 PILE REPAIR
TYPE 2 PILE REPAIR
TYPE 3 PILE REPAIR
APPROX. WATERLINE

NOTE: PILES AND REPAIRS NOT SHOWN BELOW WATERLINE FOR CLARITY.

TYPICAL SECTION

SCALE: 1" = 4'

FIGURE 2

ALTERNATIVE A

CHRISTINA STREET FEASIBILITY STUDY

NEWTON & NEEDHAM, MA

JUNE 16, 2021

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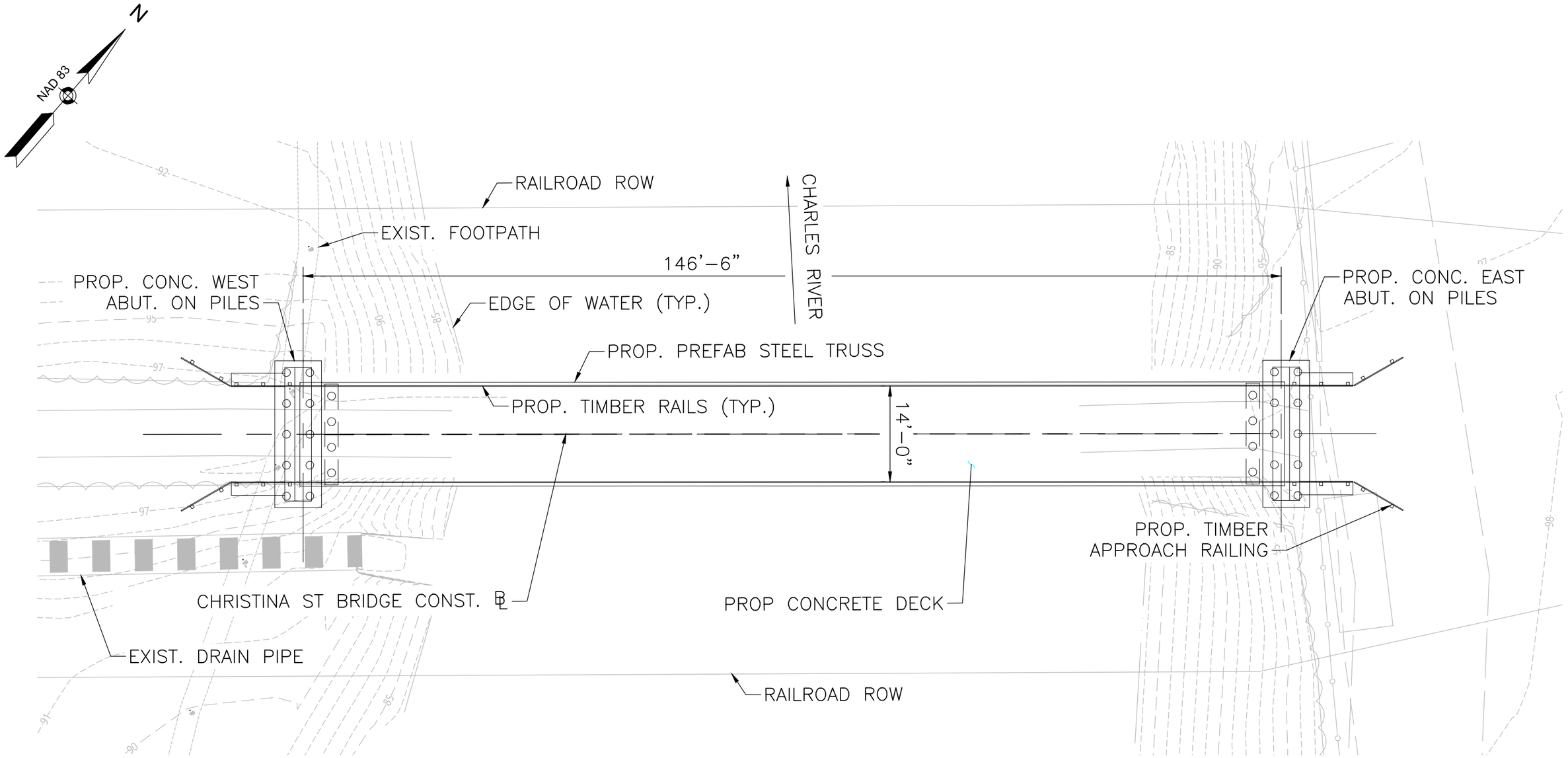

PLAN – ALTERNATIVE B

SCALE: 1" = 15'

FIGURE 3
PLAN – ALTERNATIVE B
CHRISTINA STREET FEASIBILITY STUDY
NEWTON & NEEDHAM, MA
JUNE 16, 2021

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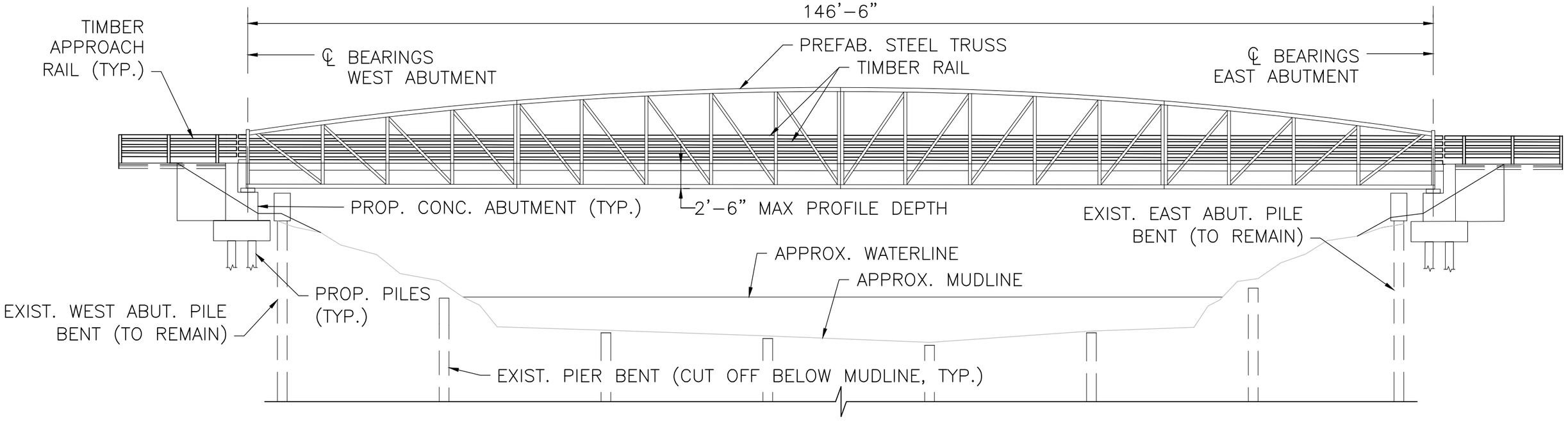
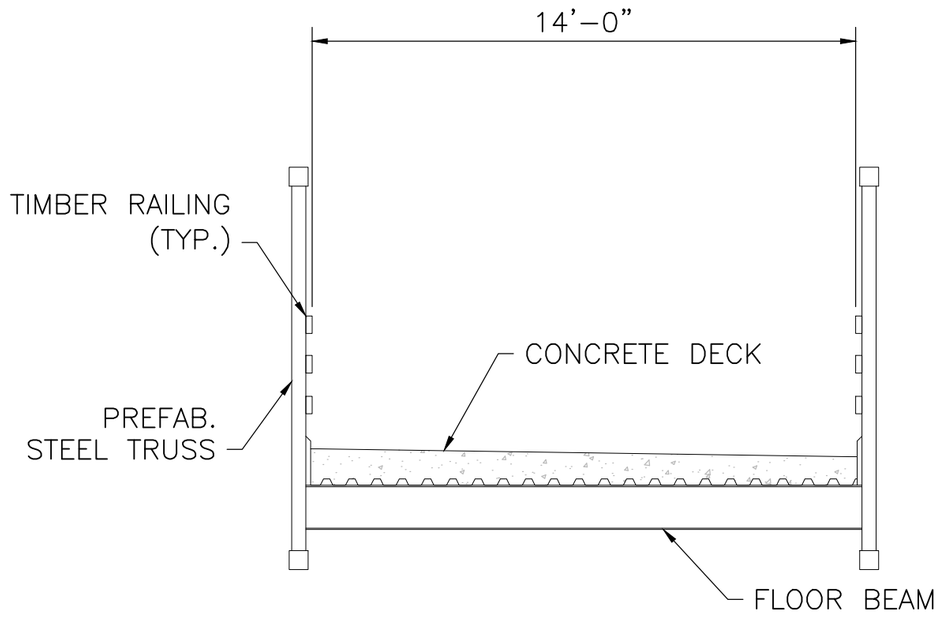


ELEVATION

SCALE: 1" = 12'



TYPICAL SECTION

SCALE: 1" = 4'

FIGURE 4
ALTERNATIVE B
CHRISTINA STREET FEASIBILITY STUDY
NEWTON & NEEDHAM, MA
JUNE 16, 2021

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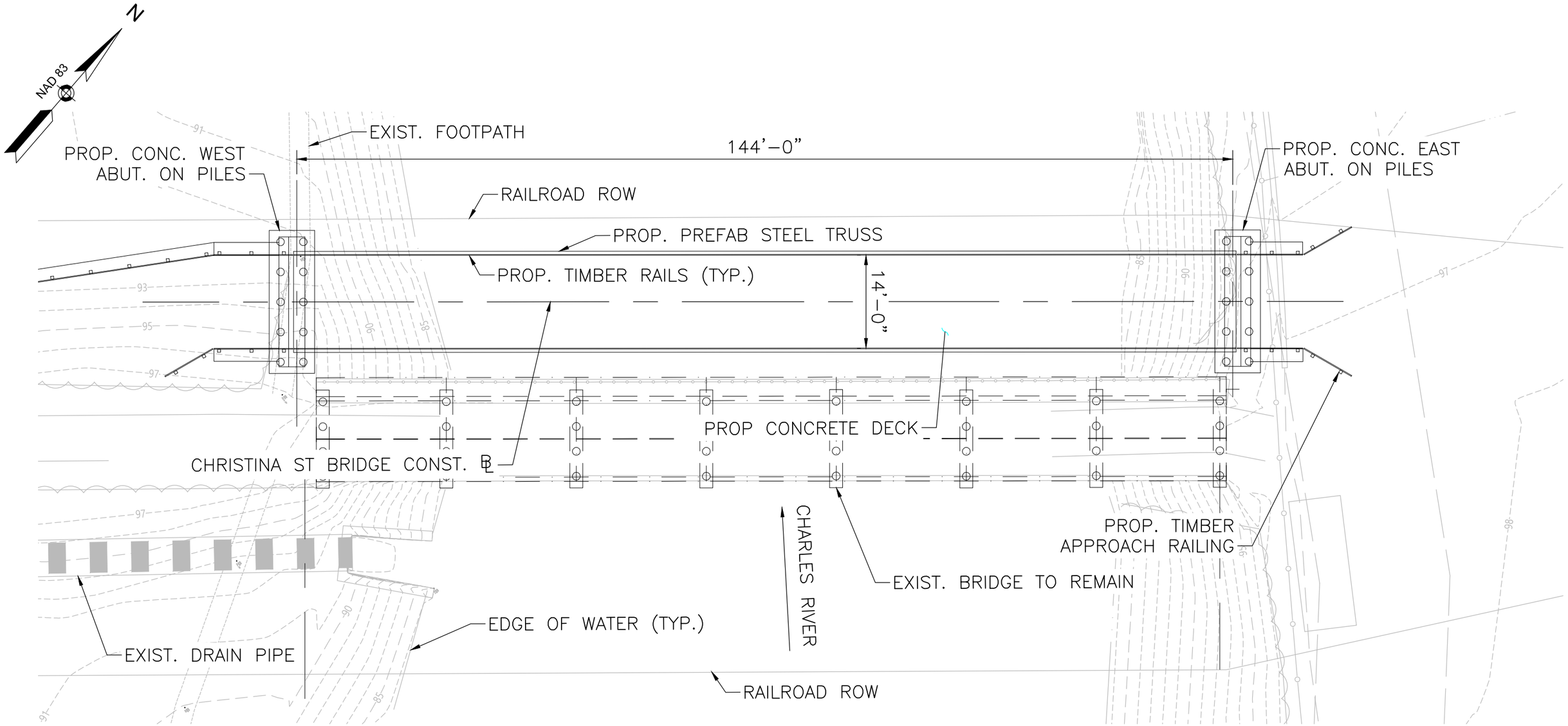

PLAN – ALTERNATIVE C

SCALE: 1" = 15'

FIGURE 5

PLAN – ALTERNATIVE C
CHRISTINA STREET FEASIBILITY STUDY
NEWTON & NEEDHAM, MA
JUNE 16, 2021

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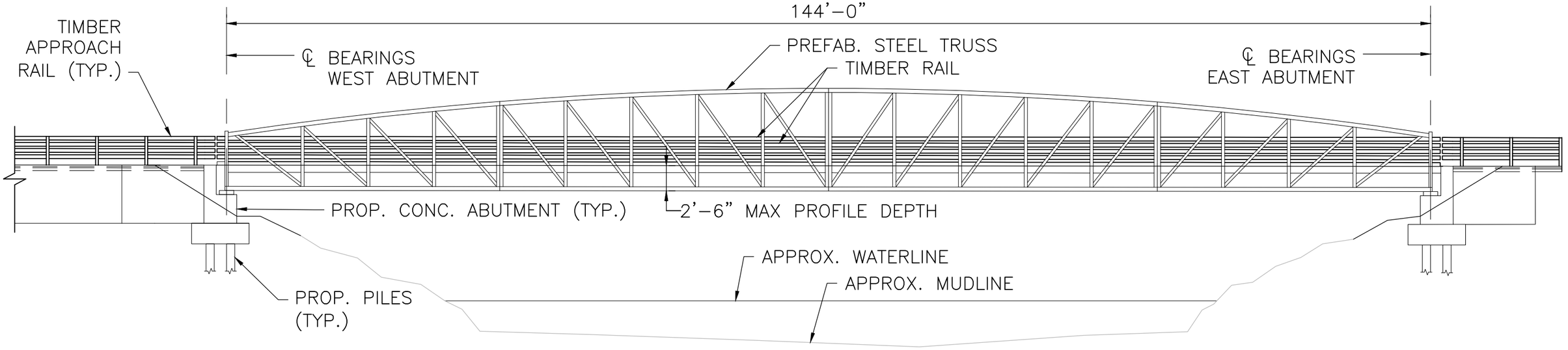
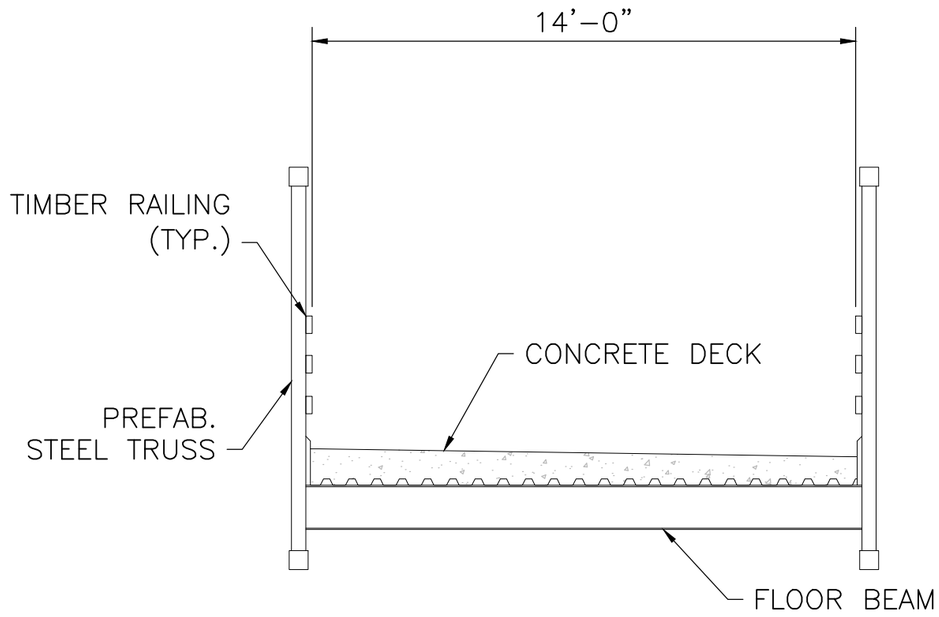


NOTE: EXISTING BRIDGE TO REMAIN AND NOT SHOWN FOR CLARITY.

ELEVATION
SCALE: 1" = 12'



TYPICAL SECTION
SCALE: 1" = 4'

FIGURE 6
ALTERNATIVE C
CHRISTINA STREET FEASIBILITY STUDY
NEWTON & NEEDHAM, MA
JUNE 16, 2021

9.2 –Bridge Cost Estimate

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Project: Christina Street Feasibility Study
Location: Newton/Needham, MA
Calculated by: KMR
Checked by: RAB
Title: Preliminary Alternatives Estimates

Project #: 15208
Sheet: Page 1 of 1
Date: 3/30/21
Date: 6/10/21

vhb
Computations

MASTER ITEMS LIST							ALTERNATIVE COSTS		
Item #	Item	Units	Unit Cost	Alt. A Quantity	Alt. B Quantity	Alt. C Quantity	Alt. A - Rehab	Alt. B - Truss on Alignment	Alt. C- Truss off Alignment
115.1	DEMOLITION OF BRIDGE	LS	$195,000.00	0.25	1	0	$ 48,800	$ 195,000	$ -
140	BRIDGE EXCAVATION	CY	$44.00	36	228	961	$ 1,600	$ 10,100	$ 42,300
151.2	GRAVEL BORROW FOR BACKFILLING STRUCTURES AND PIPES	CY	$55.00	30	220	770	$ 1,700	$ 12,100	$ 42,400
901	4000 PSI, 1 1/2", 565 Cement Concrete	CY	$1,200.00	15	70.3	240.4	$ 18,000	$ 84,400	$ 288,500
905	4000 PSI, 3/8", 660 Cement Concrete	CY	$6,600.00	8	0	0	$ 52,800	$ -	$ -
909.2	CEMENTITIOUS MORTAR FOR PATCHING	SF	$127.50	410	0	0	$ 52,300	$ -	$ -
910.1	STEEL REINFORCEMENT FOR STRUCTURES - EPOXY COATED	LB	$3.15	2300	10600	36100	$ 7,300	$ 33,400	$ 113,800
921.3	LAM. ELASTOMERIC BEARING W/ ANCHOR BOLTS (101 TO 150K)	EA	$4,000.00	0	2	2	$ -	$ 8,000	$ 8,000
922.3	LAM. ELASTOMERIC BEARING W/O ANCHOR BOLTS (101 TO 150K)	EA	$3,500.00	0	2	2	$ -	$ 7,000	$ 7,000
943.12	STEEL PIPE PILE 12" OUTSIDE DIATMER	FT	$200.00	0	900	900	$ -	$ 180,000	$ 180,000
945.01	STEEL ENCASED CONCRETE PILE REPAIRS - TYPE 1	EA	$4,835.00	14	0	0	$ 67,700	$ -	$ -
945.02	STEEL ENCASED CONCRETE PILE REPAIRS - TYPE 2	EA	$14,632.00	7	0	0	$ 102,500	$ -	$ -
945.03	STEEL ENCASED CONCRETE PILE REPAIRS - TYPE 3	EA	$26,718.00	3	0	0	$ 80,200	$ -	$ -
948.5	PILE SHOES	EA	$200.00	0	20	20	$ -	$ 4,000	$ 4,000
955.1	ALT. A - SUPERSTRUCTURE REHABILATATION	LS	$190,000.00	1	0	0	$ 190,000	$ -	$ -
994.1	TEMPORARY PROTECTIVE SHIELDING	LS	$30,000.00	1	1	0.2	$ 30,000	$ 30,000	$ 6,000
995.01	ALT. B - STEEL TRUSS SUPERSTRUCTURE	LS	$727,650.00	0	1	0	$ -	$ 727,700	$ -
995.02	ALT. C - STEEL TRUSS SUPERSTRUCTURE	LS	$715,400.00	0	0	1	$ -	$ -	$ 715,400
						Bridge Subtotal =	$ 652,900	$ 1,291,700	$ 1,407,400
						25% Contingency =	$ 816,125	$ 1,614,625	$ 1,759,250
						20% Rehab Risk Contingency =	$ 979,350	-	-
						Inflation for Construction Year 2026=	$ 1,163,161	$ 1,964,438	$ 2,140,397
						Bridge Total =	**$ 1,164,000**	**$ 1,965,000**	**$ 2,141,000**

Notes: 1. Demo cost doesn't include ties, ballast (civil items).
2. Rehab option is for footprint bridge (a 14ft timber deck and railing system).
3. Rehab risk contingency is included to account for unknowns due to limited field inspections and material sampling.

UNITS: 'LS'=Lump Sum, 'CY'=Cubic Yard, 'SF'=Square Foot, 'LB'=Pound, 'EA'=Each, 'FT'=Foot

9.3 – Bridge Life Cycle Cost Analysis

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9.1.1 Life Cycle Cost Analysis Methodology and Assumptions

- The Life Cycle Cost Analysis (LCCA) must compare all alternatives for the same analysis period. We selected 75 years because it is equal to the design life of a new bridge.

- The costs incorporated in the LCCA include construction and maintenance costs associated with the structure only. No design fees, administrative costs, or trail approach construction costs are included in the LCCA. Design, administrative, and approach costs are assumed to be equal for all alternatives and are included in the total project budget estimate (See Appendix 9.4).

- The LCCA for Alt. A assumes: initial rehabilitation and construction, minor repairs 10 years later, full new bridge construction at the end of the rehabilitation's estimated 40-year design life, and salvage value of the new bridge (which is accounted for as a credit) at the end of the 75-year analysis period. (Note: This analysis results in an effective project "discount" for delaying the construction of a new bridge.)

- The LCCA for Alt. B assumes: initial new bridge construction and painting once 40 years after construction. The truss will have zero value at the end of the 75-year analysis period because this is at the end of its design life.

Project: Christina Street Feasibility Study
Location: Newton/Needham, MA
Calculated by: KMR
Checked by: RAB
Title: Preliminary Alternatives Estimates

Project #: 15208
Sheet: Page 1 of 1
Date: 3/30/21 (Rev 7/7/21)
Date: 6/10/21

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Computations

Discount rate, i= 3.5%
Base Year= 2026

Life Cycle Cost Analysis Alterative A				
Years n	**Discount Factor**	**Required Maintenance**	**Cost at Year n**	**Present Day Value (PDV)**
2026	1.00	Bridge Rehabilitation	$ 1,164,000	$ 1,164,000
2036	0.71	misc. repairs	$ 25,000	$ 17,723
2076	0.18	replace bridge~~/extensive repairs~~	$ 1,965,000	$ 351,840
2101	0.08	Salvage Value	$ (1,310,000)	$ (99,253)
			Total Life Cycle Cost=	$ 1,434,310
			Say=	**$ 1,435,000**

Life Cycle Cost Analysis Alterative B				
Years n	**Discount Factor**	**Required Maintenance**	**Cost at Year n**	**Present Day Value (PDV)**
2026	1.00	Steel Truss Replacement	$ 1,965,000	$ 1,965,000
2066	0.25	paint steel	$ 50,000	$ 12,629
2101	0.08	Salvage Value	$ -	$ -
			Total Life Cycle Cost=	$ 1,977,629
			Say=	**$ 1,978,000**

Life Cycle Cost Analysis Alterative C				
Years n	**Discount Factor**	**Required Maintenance**	**Cost at Year n**	**Present Day Value (PDV)**
2026	1.00	Steel Truss Replacement	$ 2,141,000	$ 2,141,000
2036	0.71	Demo of exist Structure	$ 195,000	$ 138,239
2066	0.25	paint steel	$ 50,000	$ 12,629
2101	0.08	Salvage Value	$ -	$ -
			Total Life Cycle Cost=	$ 2,291,868
			Say=	**$ 2,292,000**

9.4 – Total Project Cost Estimate

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Project: Christina Street Feasibility Study
Location: Newton/Needham, MA
Calculated by: KMR
Checked by: KGK
Title: Total Project Cost Estimate

Project #: 15208
Sheet: Page 1 of 1
Date: 6/14/21 (Rev 7/7/21)
Date: 6/15/21

vhb
Computations

TOTAL PROJECT COST ESTIMATE - ALTERNATIVE A		
Bridge Cost for Selected Alternative (Alternative A)	$	1,164,000
Approach Work Cost (Blue Heron Trail to Christina Street)	$	270,000
Engineering Design Fee (To cover Final Design)	$	143,400
Construction Administration Fee (To cover engineering support during construction)	$	50,000
Total =	$	1,627,400
Say =	**$**	**1,630,000**

TOTAL PROJECT COST ESTIMATE - ALTERNATIVE B		
Bridge Cost for Selected Alternative (Alternative B)	$	1,965,000
Approach Work Cost (Blue Heron Trail to Christina Street)	$	270,000
Engineering Design Fee (To cover Final Design)	$	223,500
Construction Administration Fee (To cover engineering support during construction)	$	50,000
Total =	$	2,508,500
Say =	**$**	**2,510,000**

TOTAL PROJECT COST ESTIMATE - ALTERNATIVE C		
Bridge Cost for Selected Alternative (Alternative C)	$	2,141,000
Approach Work Cost (Blue Heron Trail to Christina Street)	$	270,000
Engineering Design Fee (To cover Final Design)	$	241,100
Construction Administration Fee (To cover engineering support during construction)	$	50,000
Total =	$	2,702,100
Say =	**$**	**2,710,000**

9.5 – September 2020 Underwater Inspection Report

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MASSACHUSETTS HIGHWAY DEPARTMENT
UNDERWATER OPERATIONS TEAM
ROUTINE UNDERWATER INSPECTION REPORT

2-DIST	B.I.N.	BR. DEPT. NO.
6		

CITY/TOWN	8-STRUCTURE NO.	LEVEL OF INSP.	93b- INSPECTION DATE
NEWTON - NEEDHAM		IV	9/14/20

7-FACILITY CARRIED	ACCESS TO BRIDGE	UNDERWATER OPERATIONS ENGINEER
RAILROAD BRIDGE	EMBANKMENT	RANDI E. BONICA Randi E. Bonica

6-FEATURES INTERSECTED	DEPTH	VISIBILITY	TEAM LEADER (DIVE MASTER)	REPORT SUBMITTED BY:
CHARLES RIVER	2m	0.5m	RANDI BONICA	R. Bonica

BOTTOM CONDITION	CURRENT	TEAM MEMBERS
GRAVEL, SILT, BLDRS	SLIGHT	BROZ, COLLERAN, GIKAS, MANKOWSKY

ITEM 60 (Underwater) *SUBSTRUCTURE* — 2

		DEF
1. Abutments	N	
a. Pedestals	N	-
b. Bridge Seats	N	-
c. Backwalls	N	-
d. Breastwalls	N	-
e. Wingwalls	N	-
f. Slope Paving/Rip-Rap	N	-
g. Pointing	N	-
h. Footings	N	-
i. Piles	N	-
j. Scour	N	-
k. Settlement	N	-
l.		
2. Piers or Bents	N	
a. Pedestals	N	-
b. Caps	N	-
c. Columns	N	-
d. Stems/Webs/Pierwalls	N	-
e. Pointing	N	-
f. Footing	N	-
g. Piles	N	-
h. Scour	N	-
i. Settlement	N	-
j.		
k.		
3. Pile Bents	2	
a. Pile Caps	N	-
b. Piles	2	-
c. Diagonal Bracing	N	-
d. Horizontal Bracing	N	-
e. Fasteners	N	-

UNDERMINING (Y=Yes / N=No)	N

ITEM 61 *CHANNEL & CHANNEL PROTECTION* — 6

		DEF
1. Channel Scour	7	-
2. Embankment Erosion	5	-
3. Debris	5	-
4. Vegetation	7	-
5. Utilities	N	-
6. Rip-Rap/Slope Protection	6	-
7. Aggradation	7	-
8. Fender System	N	-
a. Piles	N	-
b. Diagonal Bracing	N	-
c. Horizontal Bracing	N	-
d. Wales	N	-
e. Fasteners	N	-
f. Ladders	N	-

ITEM 59 *SUPERSTRUCTURE* (If any part done by divers)

		DEF
	N	-
	N	-
	N	-

ITEM 62 *CULVERTS* — N

		DEF
1. Roof	N	-
2. Floor	N	-
3. Walls	N	-
4. Headwalls	N	-
5. Wingwalls	N	-
6. Pipe	N	-
7. Protective Coating	N	-
8. Embankment	N	-
9. Wearing Surface	N	-
10. Railing	N	-
11. Sidewalks	N	-
12. Utilities	N	-
13. Member Alignment	N	-
14. Deformation	N	-
15. Scour	N	-
16. Settlement	N	-

UNDERMINING (Y=Yes / N=No)	N

DEFICIENCY REPORTING GUIDE

DEFICIENCY: A defect in a structure that requires corrective action.

CATEGORIES OF DEFICIENCIES:

M= Minor Deficiency - Deficiencies which are minor in nature, generally do not impact the structural integrity of the bridge and could easily be repaired. Examples include but are not limited to: Spalled concrete, Minor scouring, etc.

S= Severe/Major Deficiency - Deficiencies which are more extensive in nature and need more planning and effort to repair. Examples include but are not limited to: Moderate to major deterioration in concrete, Exposed and corroding rebars, Deteriorated timber piles, Considerable settlement, Considerable scouring or undermining, etc.

C-S= Critical-Structural Deficiency - A deficiency in a structural element of a bridge that poses an extreme unsafe condition due to the failure or imminent failure of the element which will affect the structural integrity of the bridge.

C-H= Critical-Hazard Deficiency - A deficiency in a component or element of a bridge that poses an extreme hazard or unsafe condition to the public, but does not impair the structural integrity of the bridge. Examples include but are not limited to: Any part of piles or fender system which are projecting outward and may become a safety hazard for the navigational traffic, etc.

URGENCY OF REPAIR:

I= Immediate- Inspector(s) immediately contact District Bridge Engineer to report the Deficiency and to receive further instruction from him/her].

A= As soon as possible- [Action/Repair should be initiated by District Maintenance Engineer or the responsible Party (if not a State owned bridge) upon receipt of the Inspection Report.]

P= Prioritize- [Shall be prioritized by District Maintenance Engineer or the Responsible Party (if not a State owned bridge) and repairs made when funds and/or manpower is available].

X=UNKNOWN N=NOT APPLICABLE H=HIDDEN/INACCESSIBLE R=REMOVED

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8-STRUCTURE NO.	INSPECTION DATE
NEWTON - NEEDHAM				9/14/20

REMARKS

GENERAL REMARKS

An underwater inspection was requested for the abandoned railroad bridge over the Charles River in Newton- Needham. The MassDOT Underwater Operations Dive Team inspected the bridge on September 14, 2020.
The railroad bridge spans the Charles River and is at the Newton and Needham town line. It is located upstream of Highland Ave., Needham/Needham St., Newton.

Bents are numbered from left to right, looking downstream. Piles are lettered from the upstream end.

The bridge has seven spans. Each bent consists of four concrete piles with a concrete bent cap. Four bents are in the water and two bents are in the dry. Two outside caps and piles are considered stub/spillthru abutments. Stub abutments were not inspected. A short section of the piles are visible where the caps are undermined. Large boulders and crushed stone are visible under and behind the right stub abutment.

Best access to the bridge is from the Needham embankment off a bike trail, off 4th Ave., Needham.

ITEM 60- SUBSTRUCTURE

Item 60.3 - Pile Bents
Item 60.3.b - Piles

Four bents are in the water. All bents have four concrete piles with steel forms, 1.2' diameter. End piles are battered. Distance between piles is 4', measured below the cap. Bents are 20' on center. Outside steel is rusty and deteriorated above the waterline. Concrete is exposed for a height of approximately 3' above the waterline, where the steel is 100% deteriorated. Steel appears to be forms for the concrete and not structural. Exposed concrete has heavy concrete abrasion probably resulting from ice damage.
The upstream piles ('A") in Bents #3, #4, and #5 have a 2'-3' section of pile missing above the waterline. Exposed concrete is rubble concrete with large aggregate exposed. No steel reinforcement is visible.
Bent #1, Pile 'A' has a horizontal 1/4" crack, 1' above the mudline.
Bent #4, Pile 'D' has a vertical 1/8" crack in the concrete and steel, 6' high above the waterline. There is also a 1/4" diagonal crack in the concrete and steel and steel is starting to crush.
Bent #5, Pile 'B' has concrete deterioration in the upstream face, 2' high, 0.2' penetration.

ITEM 61 - CHANNEL AND CHANNEL PROTECTION

Item 61.2 - Embankment Erosion

The downstream right embankment has minor undercutting.

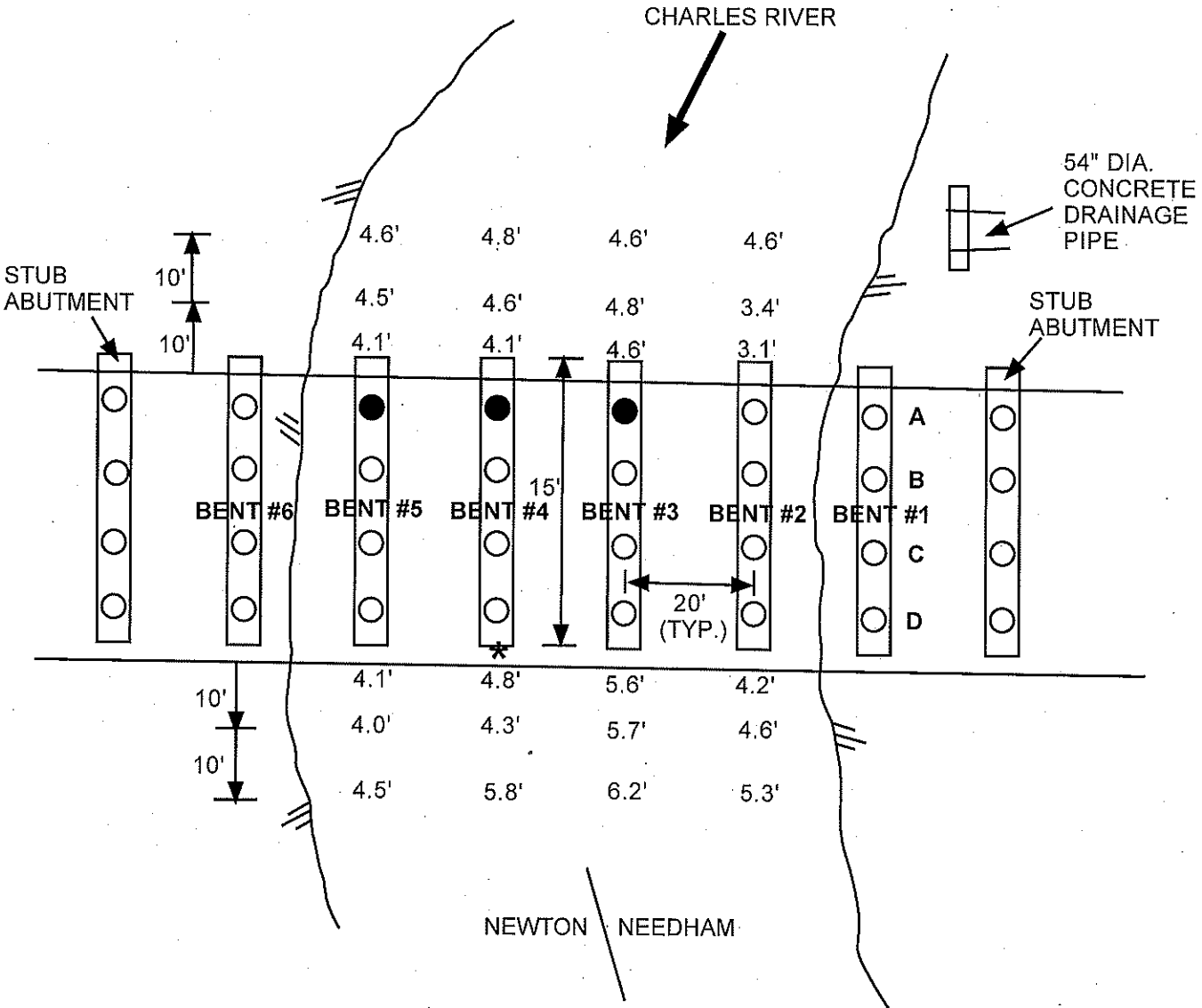
Item 61.3 - Debris

Trees are across the upstream end from the right shore to Bent #4.

Item 61.6 - Rip-Rap/Slope Protection

Riprap has slumped at the right embankment.

NEWTON - NEEDHAM **RAILROAD BRIDGE/CHARLES RIVER** **9/14/20**



* WATERLINE TO BOTTOM OF BENT CAP = Y = 9.4'

● BROKEN PILES

PLAN VIEW
(NTS)

9.6 – Approach Connection Aerial Plan

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(PR)-APPROACHES.DWG Plotted on 25-Jun-2021 11:39 AM

9.7 – Potential Approach Connection through Barry Price Center Property

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